IMPORTANT WARRANTY INFORMATION

2591

HIGH VOLTAGE AMPLIFIER

MODEL 13 4615 90

GOULD

An Electrical/Electronics Company

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Gould Model 13-4615-90 High Voltage D-C Amplifier is a single channel, medium band width, plug-in- differential d-c amplifier with an isolated output and a fully floating, guarded input. The amplifier is capable of rejecting common mode voltages up to ±1500 volts d-c or peak a-c when operating at any sensitivity from 2.5 millivolts to 1500 volts full scale.

The High Voltage d-c amplifier is designed to provide ±5 volt output signals for use in industrial environments and in areas of high electrical noise. It is used extensively in steel mills, aluminum rolling mills, paper mills, electric locomotives and other locations where high inrush currents, high voltages, or high electrical noise is expected.

Positive over-current protection for both the source equipment and the recording instrumentation is provided by current limiting, 125ma, high voltage fuses in the input leads. Over-voltage protection is provided on all sensitivity ranges for input signals up to ±1500 volts d-c or peak a-c. Additional protection against over-voltage is provided by HI-POT testing every amplifier at 4000 Volts D-C and A-C peak.

The medium bandwidth, steady state to 1000Hz, makes this compact isolation amplifier especially useful as a direct plug-in for Gould 2000 Series direct writing recorders. It receives operating power directly from a companion pendrive amplifier located in the same analog channel, or it can be used with other instruments when provided with a separate enclosure with built-in power supply.

Calibrated Zero Suppression is provided on each of 20 full scale measurement ranges, plus the choice of suppressing either positive or negative signals. A precision ten-turn potentionmeter and vernier counting dial provides DIRECT READOUT of the suppressed voltage, in terms of % full scale, with a resolution of ±0.1%. This permits the static portion of a complex signal to be suppressed by a KNOWN amount and the dynamic component to be expanded for more detailed evaluation by increasing amplifier sensitivity with the "Range" control. This feature can be used on all 20 measurement ranges for full scale display of signal variations as small as 10% of the original full scale value.

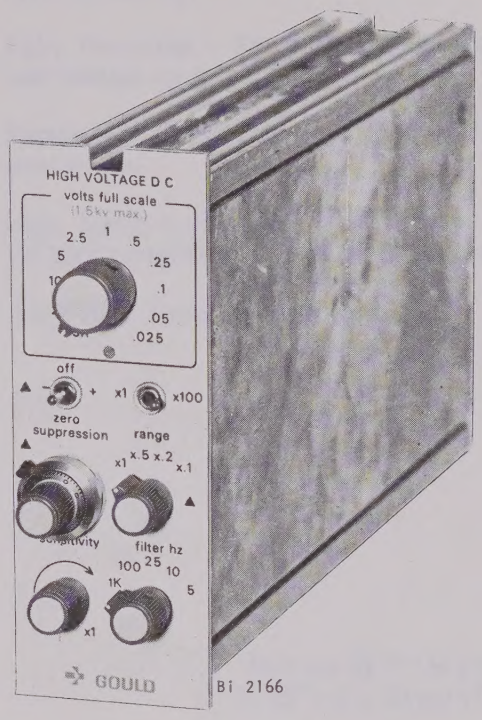


FIGURE 1-1 HIGH VOLTAGE D-C AMPLIFIER

Excellent common mode noise rejection, greater than 1,000,000 to 1 (120dB) at 60Hz, has been achieved by using a fully floating and guarded input section that is free to float up or down with any off-ground input signal. Driving the floating internal guard shield by the off-ground voltage at the signal source and providing high voltage isolation from input to output produces an amplifier which is virtually insensitive to all off-ground or common mode voltages.

The High Voltage Amplifier is provided with a five step selective low-pass output filter so that an operator can look at only the signal variations of primary interest — without superimposed higher frequency fluctuations which are often confusing. The output filter is designed so that it does not introduce any zero offset in the primary signal and produces negligible loss in calibration accuracy.

a. Important Features

1. Calibrated Zero Suppression — 40 full scale ranges from ± 25mV to ± 2500 volts.*
2. Wide Measurement Range — 2.5mV to 1500 volts full scale.
3. Low-Pass Output Filter — Five positions with front panel control.
4. Operates Off-Ground — Up to 1500 volts at any sensitivity.
5. Common Mode Noise Rejection — Greater than 140 dB (10,000,000 to 1) D-C at maximum sensitivity.
6. Fully Protected — For both over-current and over-voltage up to 1.5 KV.
7. Factory-Set Calibration — Provides 60 fixed gain ranges.
8. High Input Impedance — 10 megohms in "X 100" range and 1 megohm in "X1" range.
9. "High-Pot" Tested at 4000 volts D-C.

1.2 SPECIFICATIONS

Physical Characteristics

Dimensions	15.5 cm (6.1") H x 5.5cm (2.18") W x 33 cm (13") L
Weight	2.2Kg (4.8 lbs.)
Mounting	Retained from rear plug-in
Finish	Molded front panel — Light parchment.

Amplifier Input

Circuit	Fully Floating, Isolated, guarded, and fused
Maximum Input Voltage	±1500 Volt dc or Peak Ac
Isolation to Chassis or Output to Common	±1500 volts dc or peak ac.
Impedance	1 Megohm in X1 range 10 Megohms in X100 range
Measurement Range	X1 range 0.0025 Volts to 25 volts full scale X100 range 0.25 volts to 1500 volts full scale.
Frequency Response	filter at 1K Hz, flat 0 to 100Hz ±1.0% down 6 dB at 1.0K Hz filter at 100Hz, 6 dB down at 100Hz ±10% filter at 25 Hz, 6 dB down at 25Hz ±10%
Common Mode Rejection	140 db @ D.C., 120db @ 60Hz With 1 K ohm unbalance.

* Usable up to 1500 volts max.

Dialectric Test (10 second period)

Inputs and Guard to Chassis ..... 4000 Volts D.C.

Inputs and Guard to System Common ..... 1500 Volts D.C.

Input and Guard Fuses ..... 1/8 amp.

Amplifier Output

Circuit ..... Single ended to floating common.

Linear Voltage Range ..... ±5.0 volts into 2K ohms or more.

Impedance ..... Less than 5 ohms.

Attenuator Inaccuracy ..... ±.4% of calibrated step.

Non-Linearity ..... ±.15% of full scale.

Zero Suppression Span ..... 0 to ±100% of each input attenuator position.

Ranges .....40 ranges from ±2500* Volts to 25 millivolts.

Inaccuracy ..... (At 25°C) ±.5% suppression range.

Non-Linearity .....±.25% of suppression range.

Resolution .....±.1% of suppression range.

Stability

With Time ..... ±.02%/Week.

With Temp ..... ±.02%/°C

With Line ..... ±.02% for 10% Line Change

Filter

Range ..... 1KHz., 100Hz., 25Hz., 10Hz., 5Hz.
(-6db point and 12db/octave)

Instability ..... Referenced to X1 range setting after
30 minute warmup period.

Zero With Time ..... ±.1% Full Scale 24 Hrs.

Zero with Temp ..... ±.1% Full Scale/°C.

Zero with Line ..... ±.01% Full Scale for ±10% Line change.

Gain with Time .....±.05% of reading/24 Hrs.

Gain with Temp .....±.05% of reading/°C.

Gain with Line ..... ±.01% of reading for 10% Line change.

*Usable up to 1500 volts max.

Noise

Filter at 100Hz ..... Less than 30mv P-P DC to 100Hz with range at X.1 and source resistance of 1000 ohms.

Filter at 1KHz ..... Less than .2 volts P-P with range at X.1 and source resistance of 1000 ohms.

Front Panel Controls

Volts Full Scale ..... 11 position rotary switch with settings of .025, .05, .1, .25, .5, 1, 2.5, 5, 10, 25 and off.

X1 – X100 ..... Two position toggle switch.

Range Switch ..... Four position rotary switch permits selecting X1, X.5, X.2, or X.1 multiplier for use with zero suppression.

Sensitivity Vernier..... Provides up to 2.5X multiplication of calibrated steps.

Zero Suppression Switch ..... 3 position Toggle switch –, off, +.

Zero Suppression Control ..... 10 turn potentiometer allows calibrated setting of 0 – 100% of Volts Full Scale setting.

Filter Switch ..... 5 position rotary permits selecting 1KHz, 100Hz, 25Hz, 10Hz and 5Hz.

Balance Adjust ..... (Screw Driver Slot) sets zero of amplifier with Volts Full Scale switch in .025 and input shorted.

Internal Controls

Offset ..... 20 turn pot.

Output Zero ..... 20 turn pot, zeros output stage.

Gain ..... 20 turn pot, sets amplifier gain.

+ Suppression ..... 20 turn pot, sets ±100% suppression voltage.

– Suppression ..... 20 turn pot, sets – 100% suppression voltage.

Phase ..... Sets phase relationship between modulator driver signal and demodulator drive.

X100 Trim ..... 20 turn pot adjusts X100 voltage divider.

Environment

Temperature

Storage ..... –40° C to +75° C

Operating ..... 0° C to +50° C

Within Spec.	10 to 40° C
Humidity	95% @ 32° C Non-Condensing.
Vibration and Shock	Best Commercial Practice.
Power Requirement	±15 ± .6Vdc @ 25ma. −15 ± .6Vdc @ 20ma. 13V RMS @ 180ma RMS.

1.3 Accessories

High-Voltage Input Cable Assembly, 25 Ft. Long	892684-1
High-Voltage Input Cable Assembly, 50 Ft. Long	892684-2
High-Voltage Input Cable Assembly, 100 Ft. Long	892684-3
Signal Input Connector	11-5407-02.

SECTION II

INSTALLATION

2.1 GENERAL

This section describes the checks and inspections that should be made upon receiving the Gould High Voltage D.C. Preamplifier Model 13-4615-90 with a 2000 series unit. It covers; installation procedures, signal input connections, and outline dimensions.

2.2 INITIAL INSPECTION

Prior to attempting any electrical connections or operation visually examine the unit for; broken or loose knobs, dented or nicked panels and broken or chipped rear connectors.

2.3 INSTALLATION

Preamplifier Model 13-4615-90 may be mounted in Gould 2000 Recorder frames, Gould portable case or rack mounted separately in a Gould rack adapter kit.

a. Insertion

To install the preamplifier into its appropriate slot:

1. Slide the preamplifier into the enclosure until the rear output card edge connector is engaged.

2. Tighten the rear retaining screw. This locks the preamplifier into the enclosure.

3. Connect the 2-pin plastic input signal connector and secure it by turning the threaded plastic locking ring clockwise.

b. Removal

1. Disconnect the input connections with a counterclockwise turn of the connector and pull.

2. Loosen the rear retaining screw. The preamplifier will move forward about 1/8 of an inch.

3. Carefully slide the entire preamplifier out of the Gould 2000 enclosure.

2.4 SIGNAL CONNECTIONS

a. General

Gould preamplifier Model 13-4615-90 is a fully floating, isolated, guarded and fused dc amplifier.

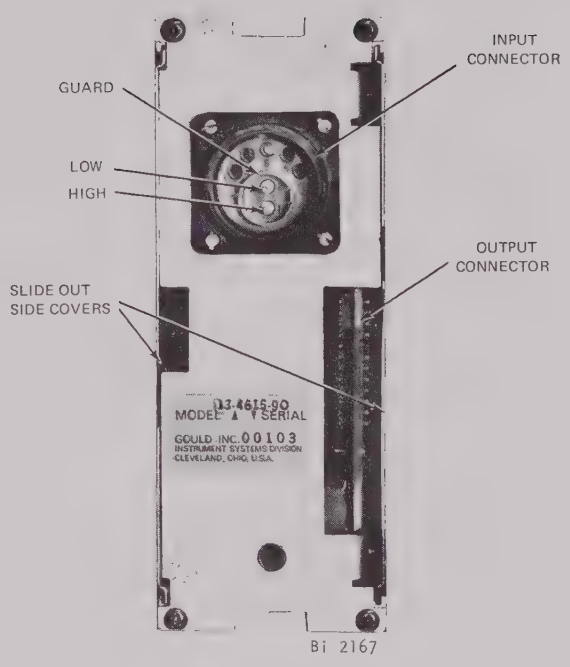


FIGURE 2-1 REAR VIEW

The input and output are isolated from each other and chassis. See Figure 2-2.

The amplifier can be used with any signal input up to 1500 volts peak. The source may be floating, balanced to ground, single ended-grounded, balanced floating, balanced driven off ground and single ended driven off ground.

b. Input Connection Hardware

NOTE: For signal input connections, use the special connector provided with the preamp (Gould Model number 11-5407-02).

Connections to the preamplifier are made at the rear. (Figure 2-1.) When constructing a cable other than the standard Gould cable P/N 892684-1, -2 or -3 the cable shield must be connected to the "LOW" input lead at the signal source. (Figure 2-2)

NOTE: Always use Belden High-Voltage cable No. 83393 (Gould 264130). This cable is specifically designed by Belden in cooperation with Gould Instruments, especially for high voltage applications.

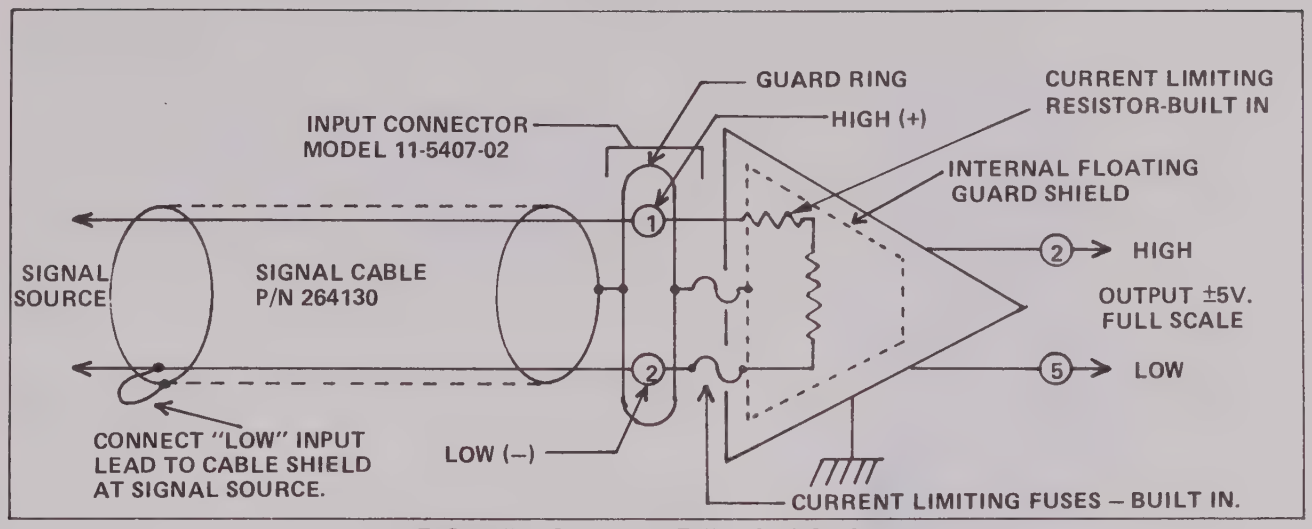


FIGURE 2-2 AMPLIFIER DIAGRAM

c. Output and Power

The amplifier is designed to operate on + and −15 volt, 25ma regulated supplies, and 13 vrms, 180 ma ac. Output and power connections are provided through an 8 pin card edge on the rear of the pre-amplifier (Figure 2-2). The mating connector is located in the recorder chassis.

The preamplifier provides a 5 volt full scale signal to the recorder. If the user desires, this output is accessible on the rear of the recorder by means of a miniature phone jack.

2.5 OUTLINE DIMENSIONS

Refer to Figure 2-3 for outline dimensions.

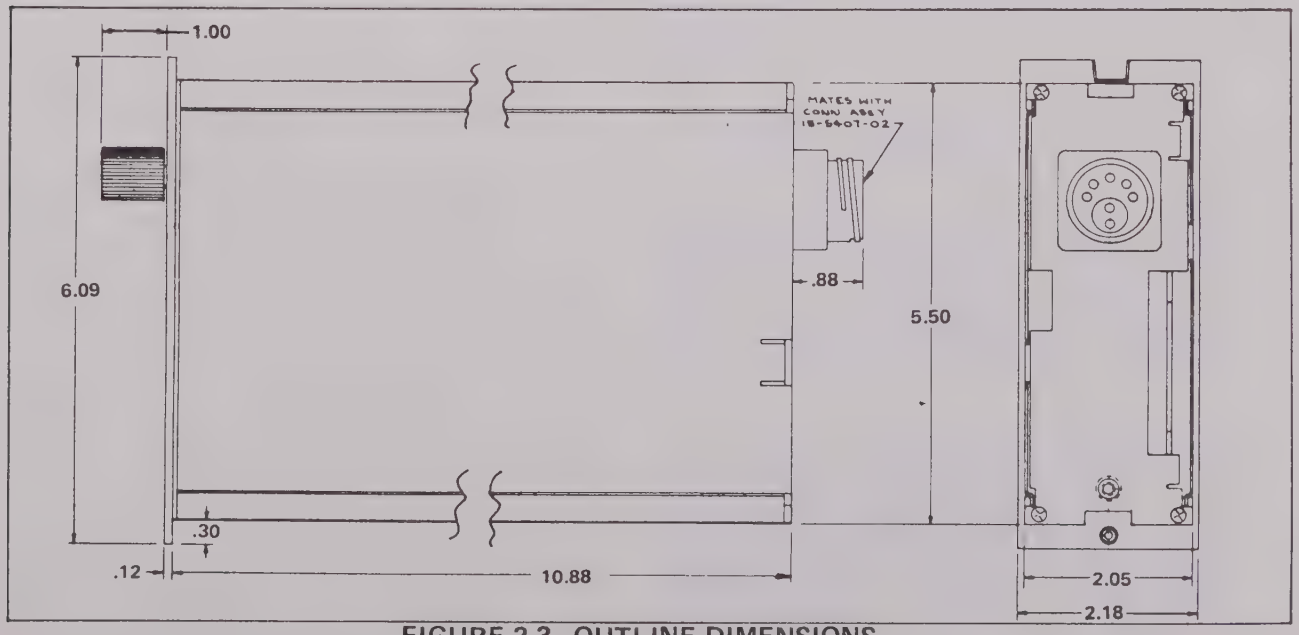


FIGURE 2-3 OUTLINE DIMENSIONS

SECTION III

OPERATION

3.1 GENERAL

This section describes and illustrates the controls of the High Voltage Amplifier and provides instructions for proper operation. Before attempting to use the amplifier it is imperative that the operator completely understand the functioning of the controls and the required input/output specifications.

3.2 FRONT PANEL CONTROLS

The items listed below correspond to controls shown in Figure 3-1.

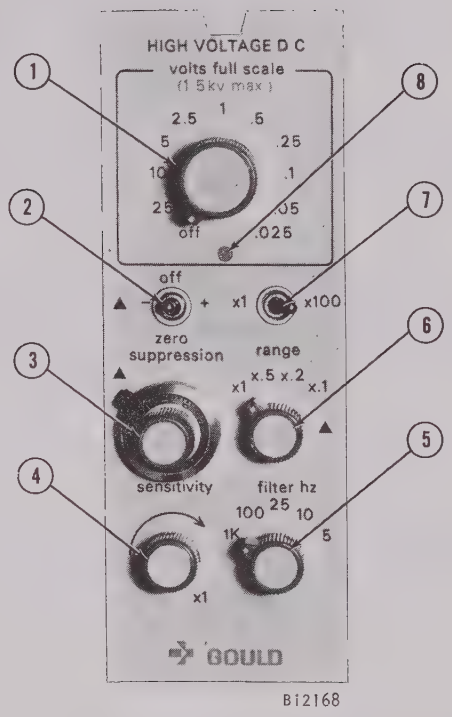


FIGURE 3-1 FRONT PANEL

ITEM	CONTROL	DESCRIPTION
1	Volts Full Scale (attenuator (S101) . .	Eleven position rotary switch with settings of .025, .05, .1. .25, .5, 1, 2.5, 5, 10, 25 and Off. Settings represent the input necessary to cause full scale deflection.
2	Zero Suppression Switch (S104)	Three position toggle switch —, OFF, and + activating the zero suppression circuit.
3	Zero Suppression Vernier (R102)	Ten turn potentiometer with a calibrated dial. A full clockwise setting of 10.0 gives a suppression of 100% of that indicated by the Volts Full Scale attenuator. Lesser settings give proportionally reduced amounts of suppression. This control is fitted with locking knob to prevent inadvertent turning.
4	Sensitivity (R101)	This control is a variable resistor which may be used to set the full scale calibration to values other than the 10 distinct steps allowed by S101, above. In the X1 or full clockwise position (detented), the sensitivity is maximum and the VOLTS FULL SCALE is as set on switch S101. As the SENSITIVITY control is turned counter-clockwise, the sen-

ITEM	CONTROL	DESCRIPTION
4	(Continued)	sitivity is reduced to a point such that, at full counter-clockwise, the volts full scale indicated by switch S101 is multiplied by at least 2.5. This allows full scale to be continuously adjustable over the entire voltage range.
5	Filter (S105)	A five position rotary switch permits selecting low-pass output filter positions at 5, 10, 25, 100 and 1000 Hz. The output is -6dB down at the frequency selected.
6	Range Control (S103)	Four position rotary switch that changes amplifier gain by the multiple indicated on the front panel. This control may be used with the zero suppression feature to further expand the dynamic component of a complex signal.
7	X1—X100 Multiplier (S402)	Multiplies Volts Full Scale sensitivity by either X1 or X100.
8	Balance Adjust (R408)	(Screw driver adjust) Sets zero of amplifier with Volts Full Scale switch in the .025 position and inputs shorted. (Refer to Calibration Section V.)

3.3 INTERNAL CONTROLS

Refer to Figure 3-2 for Internal Controls

CONTROL	DESCRIPTION
Offset (R406)	Adjusts for minimum offset of Sensitivity Control.
Output zero (R207)	Adjusts output stage to zero when amplifier is Off.
Gain (R210)	Adjusts output to +5.0Vdc for 100% full scale input.
+ Suppression (R211)	Adjusts +100% zero suppression voltage.
— Suppression (R212)	Adjusts — 100% zero suppression voltage.
Phase (R203)	Adjusts phase relationship between modulator drive and demodulator drive.
X100 Trim (R404)	Adjusts ratio of X100 voltage divider.

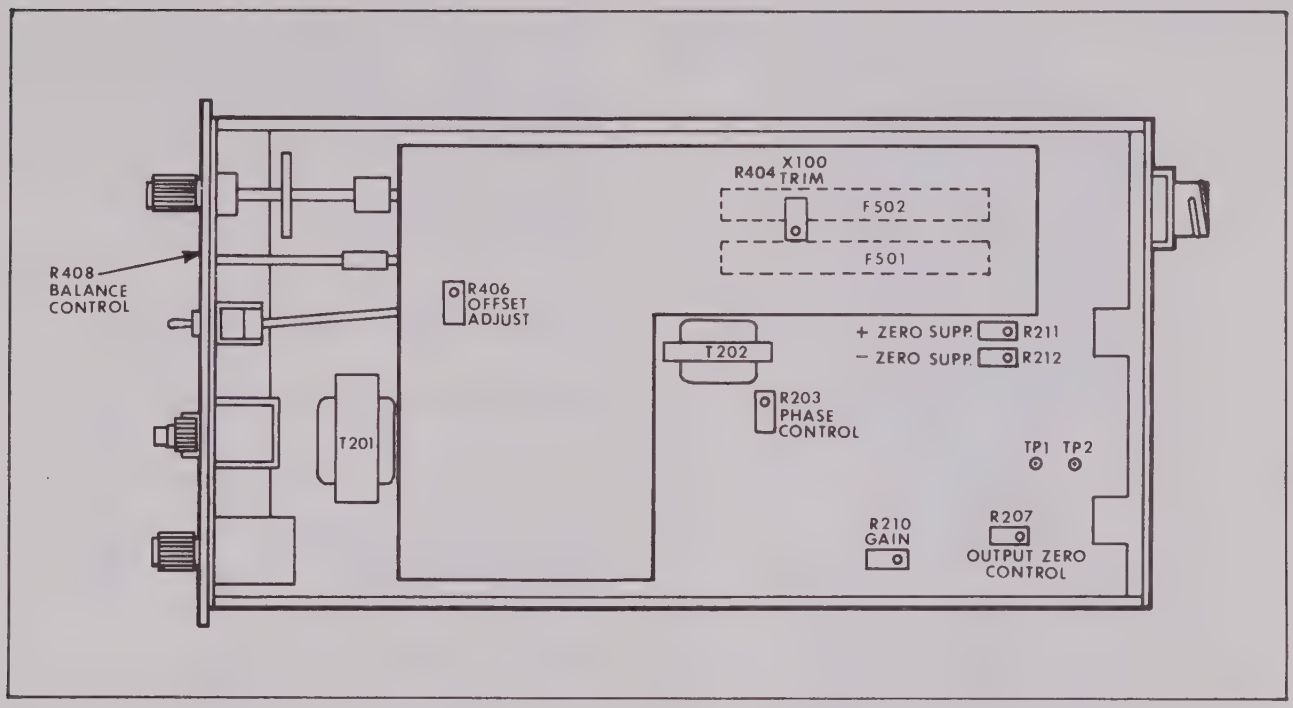


FIGURE 3-2 INTERNAL CONTROLS

3.4 PRELIMINARY OPERATION

CAUTION: ALL PROCEDURES OUTLINED IN SECTION II, INSTALLATION, SHOULD BE COMPLETE BEFORE ATTEMPTING OPERATION OF THIS UNIT.

1. Set amplifier front panel controls as follows:

Volts Full Scale –	OFF
Zero Supp. –, OFF, + –	OFF
X1–X100 –	X100
Zero Supp. Vernier –	00
Range –	X1
Sensitivity –	X1
Filter –	100Hz

2. Operate recorder at nominal chart speed and position pen to desired location on chart, using pen position control located on the recorder.
3. Set amplifier sensitivity and filter to desired operating positions.
4. Stop recorder and connect input signal to amplifier.
5. Amplifier is now ready for normal operation.

3.5 OFF–CENTER ZERO OPERATION

It is often desirable to record signals which always appear on one side of zero. In such cases, the pen position control, on the recorder, is used to displace the output. Displacement may be as much as 25 chart divisions either side of chart center. Operation in this manner does not affect the performance of the preamplifier. Specifications remain unchanged.

3.6 UNCALIBRATED OPERATION

To obtain more useful records, it may be desirable to operate the amplifier with the sensitivity X1 vernier control backed-off from the detent position. The only specifications affected by operating the instrument in this manner are the calibrated sensitivity and zero suppression. All other specifications remain unchanged.

3.7 CALIBRATED ZERO SUPPRESSION

a. General

Zero suppression permits the dc component of a complex wave form to be suppressed, thus allowing

a small dynamic portion to be further amplified. Calibrated zero suppression indicates the magnitude of the dc voltage component which has been suppressed. The zero suppression is independent of Range Switch setting which controls output sensitivity. This feature permits the amplifier gain to be changed without resetting the zero suppression.

To examine the dynamic component (or components) of a signal with a static (dc) level proceed as follows:

1. Turn the VOLTS FULL SCALE control to the OFF position.
2. Place the X1/X100 multiplier switch in the X100 position.
3. Place the range control in the X1 position.
4. Place ZERO SUPPRESSION toggle switch (–OFF+) to the OFF position and the VERNier control fully counterclockwise.
5. Turn X1 SENSITIVITY control fully clockwise to the detent position.
6. Operate the recorder at a nominal speed and set the pen to chart center.
7. Advance the VOLTS FULL SCALE control clockwise until the pen approaches the edge of the chart.
8. Note whether the signal is positive or negative in polarity.
9. Set the ZERO SUPPRESSION switch (–OFF+) to the appropriate position and use the VERNIER dial to bring the pen to the center of the chart.
10. Advance the Range Control clockwise until the desired sensitivity of the dynamic signal is obtained.
11. Read the peak-to-peak value of the dynamic signal from the recorder chart.
12. The average value of the static portion of the signal is read from the VERNIER dial.
13. Run a short length of chart at 100 millimeters per second or higher and determine the predominant frequencies which make up the dynamic component of this complex signal.

EXAMPLE # 1: The input voltage for the example is a 5Hz, 1 Volt P-P sinewave, offset by a 4.5 Volt DC level. Refer to Figure 3-3 zero suppression chart for measurement of the signal.

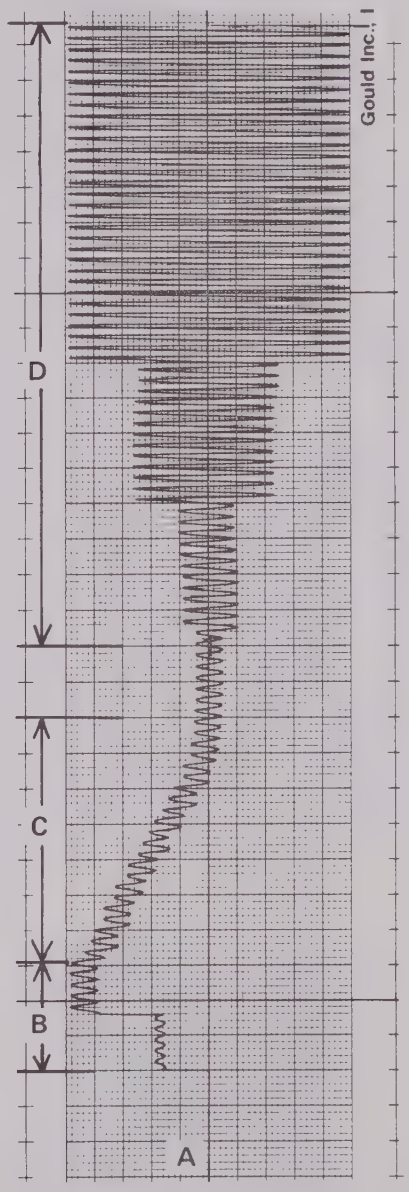


FIGURE 3-3 ZERO SUPPRESSION CHART

For above example #1 the amplifier controls are set as follows:

Volts Full Scale –	OFF
Range –	X1
Zero Supp. –	OFF
X1– X100 Mult. –	X1
Filter –	100 Hz.
Zero Supp. Vernier –	CCW
Sensitivity –	Detent Position

1. Set recorder to 5mm/sec. and pen to chart center. (A)

2. Place the Zero Suppression toggle switch to the plus (+) position.

3. Rotate the Volts Full Scale control from OFF to the 10V range placing the signal on the chart edge. (B)

4. Rotate the Zero Suppression Vernier Control clockwise to bring the signal to the center of the chart. (C)

5. Turn the range control from the X1 position to the X.1 position. The chart is now calibrated for 1 Volt full scale. (D)

6. The amount of DC signal suppressed can be read directly from the Zero Suppression vernier dial. The amount of suppression should be 45% or 4.5V suppressed due to the input offset voltage of 4.5Vdc.

Example # 2: Figure 3-4 shows the chart of a H.V. amplifier measuring a 75 Volt, 150Volt and 250 Volt dc signal. Set-up is as described.

Controls are set as follows:

Volts Full Scale —	OFF
Range —	X1
Zero Suppression —	OFF
X1—X100 Mult. —	X100
Sensitivity —	Detent Position

1. Set recorder to 5mm/sec. and pen to right chart edge.

2. Rotate the Volts Full Scale control from OFF to the 2.5 Volt position.

3. Apply the specified voltage in Figure 3-4 and read chart accordingly. Each division is 5 volts.

3.8 LOW-PASS SELECTIVE FILTERING

The Gould High Voltage Amplifier is provided with a selective low-pass output filter so that an operator may look at only the signal variations of primary interest, without superimposed higher frequency fluctuations which are often confusing. The filter is designed so that it does not introduce any zero offset in the signal and produces negligible loss in calibration accuracy.

The selective filter in this amplifier is an active, 2 pole, low-pass design which has a rolloff of -40 dB (-99%) per decade (a 10 to 1 change in frequency). Thus, with the filter set in the 100Hz position a 1000Hz signal will be attenuated -40dB (-99%) and a 10,000 Hz signal will be down -80dB (-99.99%). On the lower side of the set point a 10 Hz signal will be attenuated about 0.5 dB (5%). Figure 3-5 shows the action of the low-pass filter on a 60Hz sine wave as the filter is switched through various operating positions and demonstrates that selective filtering can be injected without producing D-C offset. This filter is controlled by a five position rotary switch with selection points at 5, 10, 25,100 and 1000Hz.

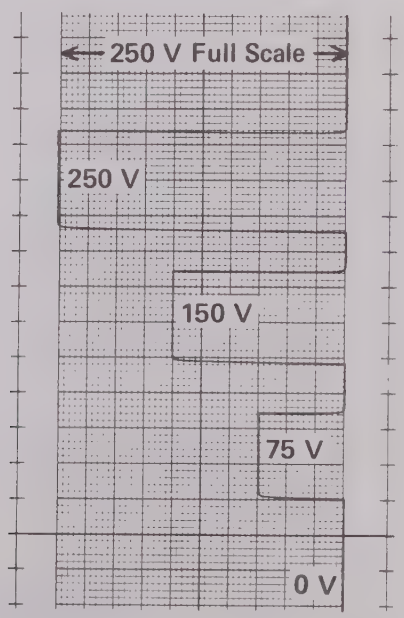


FIGURE 3-4 DC LEVEL CHART

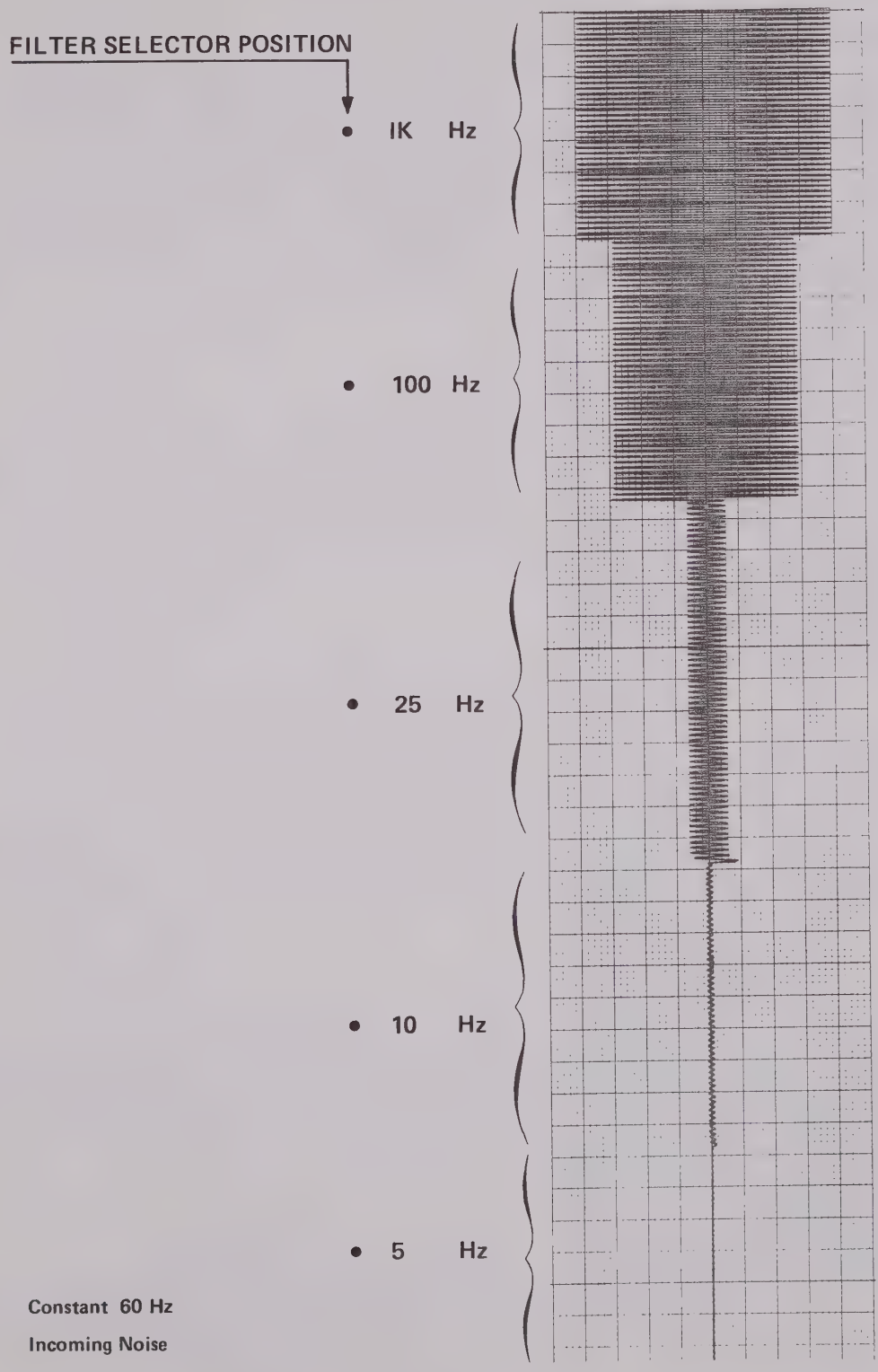


FIGURE 3-5 EFFECT OF FILTER ON OUTPUT

SECTION IV

THEORY OF OPERATION

4.1 GENERAL

The High Voltage Preamp, Model 13-4615-90 consists of an input X1-X100 voltage divider, an interstage attenuator, a gain ranging input amplifier, a summing amplifier, a 10KC filter, a modulator-amplifier, a modulation-isolation transformer, a demodulator, 10Khz multivibrator, a filter amplifier, a zero suppression circuit and an output amplifier-buffer. (Refer to Block Diagram Figure 4-1).

4.2 CIRCUIT DESCRIPTION

a. X1-X100 Divider

The input signal is applied to the X1-X100 divider consisting of R401 thru R404. The voltage divider R401, R402 and R403 divides the signal by 100 with the division ratio adjusted to .01 by X100 trim pot R404. The signal is applied to the attenuator S401 after being divided.

b. Volts Full Scale Attenuator

Selection of the interstage attenuator network and gain resistors for U403 is made by switch S401. Resistors R412 and R414 thru R419 provide the proper gain for input amplifier U403, in relationship to the volts full scale setting. The correct gain is obtained when resistors R415 thru R419 are switched across resistor R414. The gain is dependent upon the volts full scale attenuator setting. The balance pot R408 compensates for the offset voltage of U403.

c. Summing Amplifier

The output of U403 is divided down in resistor network U406 and summed with an offset correction voltage from R-406, Pin 2. Summing amplifier U404-2 amplifies and combines these two signals to produce a non-inverted output at Pin 7 of U404-2.

d. 10Khz Filter

The output of U404-2 is applied to the 10Khz filter consisting of R.C. network U407-2 and C407. The filter limits any 10Khz signals which might be present with the input signal.

e. Modulator and Isolation Amplifier

Amplifier U404-4 with resistor network U407 modulate the input signal with a 10Khz square wave generated by the modulator drive (Step g) and apply it to transformer T-202. A 1 volt d.c. signal at Pin 6 of input amplifier U403 becomes a 1 volt peak 10Khz square wave at pin 14 of amplifier U404-4. Transformer T-202 provides isolation between the isolator board signal, the output board and the recorder's system ground.

The 10Khz modulator drive signal is coupled to the isolator amplifier board by optical isolator U405. The signal at the collector of Q203 is a 10Khz square wave, 1 Volt P-P, which drives the LED between pins 1 and 2 of U405. The output of U405, Pin 4, is 1.2 volts P-P and is applied to comparitor U404-3. The output of U404-3 is a 9 volt P-P square wave that bias's Q402 off and on. As Q402 switches, modulator amplifier U404-4 changes at a 10Khz frequency from inverting to non-inverting operation. The amplitude of the square wave output from U404-4 is proportional to the input signal.

f. Demodulator

The 10Khz signal from the isolation amplifier is coupled by T202 to the demodulation stage Q201 and Q202. The bases of both transistors are synchronously driven by the 10Khz demodulator drive signal (step g.). The full wave demodulated signal is summed together by resistor network U205 and amplifier U201-2.

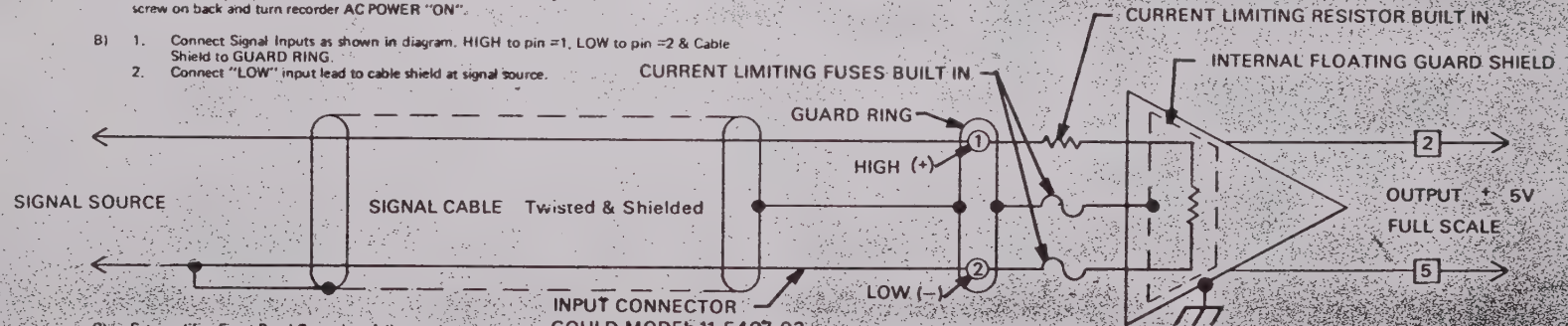
g. 10Khz Modulator Drive

Amplifiers U202-2, -3, -4 and resistor network U204 make up the 10Khz modulator drive circuit. R-203 adjusts the phase relationship between the modulator drive and the demodulator drive. Maximum output signal is adjusted by R203. The modulator drive output U202-3, pin 1, is a 4 volt P-P 10Khz square wave applied to Q203 of the modulator stage. The demodulator drive output U202-4, pin 7, is a 6 volt P-P 10Khz square wave that is applied to the bases of Q201 and Q202 of the Demodulator stage.

BASIC OPERATING INSTRUCTIONS — HIGH VOLTAGE D-C AMPLIFIER MODEL NO. 13-4615-90

A) Insert amplifier in GOULD RECORDER or Portable Carrying Case, secure with thumb screw on back and turn recorder AC POWER "ON".

B) 1. Connect Signal Inputs as shown in diagram. HIGH to pin #1, LOW to pin #2 & Cable Shield to GUARD RING.
2. Connect "LOW" input lead to cable shield at signal source.



C) Set amplifier Front Panel Controls as follows:
1. VOLTS FULL SCALE (Attenuator) in "OFF" position.
2. ZERO SUPPRESSION toggle switch in "OFF" position.
3. X1 or X100 sensitivity toggle switch in "X100 position.
4. ZERO SUPPRESSION vernier fully counterclockwise in "00" position.
5. RANGE selector in "X1" position.
6. SENSITIVITY Vernier fully clockwise in "X1" position.
7. FILTER (low-pass) in "100HZ" position.

D) Run Recorder Chart at 10 mm/sec and establish CHART ZERO at desired position using recorder "POSITION" control.

E) Establish full scale sensitivity —
1. If full scale input voltage is 25 volts or less turn sensitivity toggle switch to "X1" position.
2. Turn VOLTS FULL SCALE (Attenuator) to desired sensitivity.
3. Turn FILTER selector switch to desired position.

F) ZERO SUPPRESSION operation:
1. Turn ZERO SUPPRESSION toggle switch "OFF".
2. Turn ZERO SUPPRESSION vernier fully counterclockwise to "00" position.
3. Turn VOLTS FULL SCALE (Attenuator) clockwise until pen reaches max. deflection without going off chart.
4. Turn ZERO SUPPRESSION toggle switch to "+" position for positive input signal.
5. Turn ZERO SUPPRESSION vernier clockwise until desired suppression value is achieved.
6. Turn RANGE selector switch clockwise to increase dynamic component of signal.
7. Read value of suppressed voltage —10 turns on vernier provides 100% suppression of value indicated by VOLTS FULL SCALE selector switch.

G) Input Balance — small screw under VOLTS FULL SCALE selector is for periodic laboratory calibration only.

H) For further details see OPERATING and SERVICE MANUAL.

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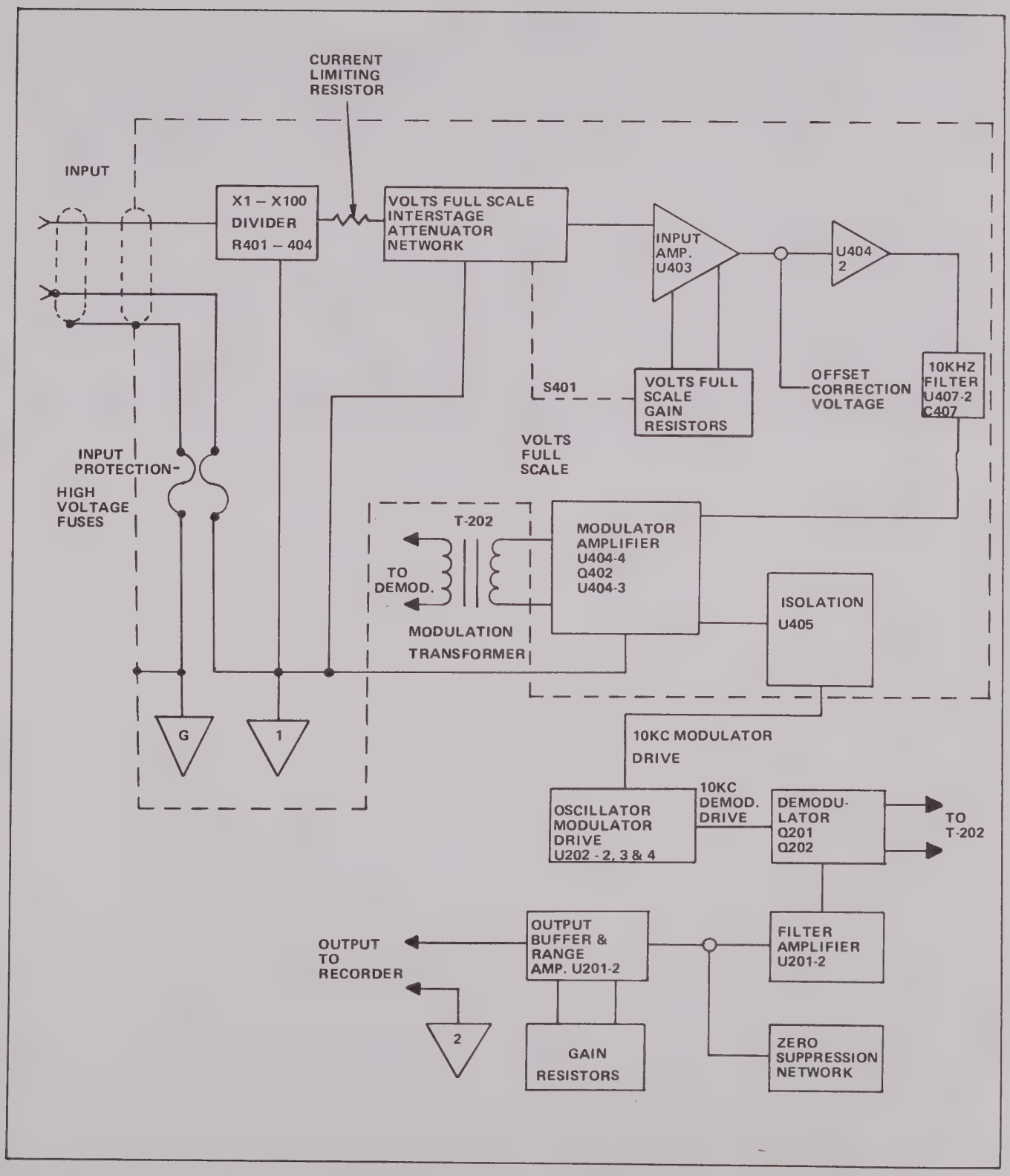


FIGURE 4-1 BLOCK DIAGRAM

h. Filter Amplifier

Amplifier U201-2 is an active filter using resistor pack U205 with capacitors C217 and C203 thru C211. These components are selected by front panel control S105 to provide the 5 cutoff frequencies of; 1000, 100, 25, 10 and 5 Hz. Each cutoff frequency is 6dB down with 12dB per octave roll off.

i. Output Buffer and Range Amplifier

The output of U201-2 is applied to the sensitivity control, R101. In the X1 or full clockwise position (detented) the amplifier is calibrated to the Volts Full Scale setting, S101. The signal on the wiper of R101 is coupled thru S101-B to the gain trim resistor R210 and applied to the output buffer and range amp U201-1. Volts Full Scale switch, S101-B removes the signal and grounds the input to U201-1 when in the "OFF" position. The zero suppression circuit is also disabled by the Volts Full Scale switch S101-A in the "OFF" position. Range switch S103 selects the gain resistors R209 and R213 thru R215 of U201-1 to expand the dynamic portion of the input signal by multiplying the gain by X1, X2, X5, or X10.

j. Zero Suppression Circuit

Zero Suppression Vernier R-102 adjusts the amount of suppression injected into the circuit. Switch S104 selects plus (+) or minus (—) suppression, and "OFF". U201-3 and U201-4 with resistor network U203 provides the stable ±6.4 volts for the suppression circuit. R211 and R212 are used to calibrate the 100% end of the suppression vernier dial. Zero suppression buffer U201-1 removes the loading effects of the zero suppression control, R-102.

SECTION V

MAINTENANCE

WARNING

THE CONFORMAL COATING (HUMISEAL TYPE 1A27), USED TO INSULATE THE OUTPUT AND ISOLATOR BOARDS, WILL PRODUCE IRRITATING FUMES WHEN HEATED WITH A SOLDERING IRON. WHEN REPLACING A COMPONENT, THE COATING SHOULD BE CUT AWAY AND COMPONENT UNSOLDERED IN AN AREA WHERE ALL FUMES CAN BE VENTED AWAY FROM THE TECHNICIAN. REFER TO SECTION 5.4 COMPONENT REPLACEMENT FOR FURTHER INFORMATION.

5.1 GENERAL

In addition to maintenance procedures, this section contains information on calibration and trouble-shooting.

5.2 MAINTENANCE

a. General Cleaing

CAUTION

1) *BEFORE ATTEMPTING TO CLEAN THE PREAMP, TURN POWER OFF AND REMOVE FROM ENCLOSURE.*
2) *AVOID USE OF CHEMICAL CLEANING AGENTS WHICH MIGHT DAMAGE PLASTIC OR PRINTED SURFACES. DO NOT USE CHEMICALS WHICH CONTAIN TOLUENE, CELLUSOLVE, ACETONE OR SIMILAR SOLVENTS.*

EXTERIOR: Remove loose dust with a soft cloth or small paint brush. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. DO NOT USE ABRASIVE CLEANERS.

INTERIOR: Dust in the interior should be removed occasionally due to its electrical conductivity under high humidity conditions. Blow off accumulated dust with dry LOW pressure air. Remove any dirt which remains with a soft paint brush or a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or printed circuit boards.

CAUTION: PREAMPLIFIER MUST BE COMPLETELY DRY BEFORE APPLYING POWER.

5.3 FUSE REPLACEMENT

The High Voltage D.C. amplifier contains a set of input fuses to insure complete protection against over current or over voltage while recording.

NOTE: Before proceeding with fuse replacement the cause of the fuse failure must be determined and corrected.

1. Remove input signals and slide unit from rack after loosening the rear retaining screw.
2. Remove right side cover.
3. Remove the four phillips head screws from the internal cover shield assembly. Figure 5-1.
4. Lift the internal shield exposing input fuses F501 and F502.
5. Fuses are now accessible and are easily replaced by lifting out blown fuses and snapping in replacement. Figure 5-1.

NOTE: Fuse is 1/8 amp, Buss Type HVA, Gould part number 248490-1.

6. Replace internal shield using phillips head screws.
7. Replace side cover.
8. Return unit to rack and secure with rear retaining screw.
9. Connect input signals to unit.

5.4 COMPONENT REPLACEMENT

Component replacement should be performed by a qualified service technician. Standard service practices for insertion and removal of electronic components should be performed along with the following added instructions.

The isolator board 891206 has been sealed with a conformal coating (humiseal, Type 1A27) part number 292133 to insure that high voltage breakdown does not occur. Special precautions must be taken when replacing a component on this board.

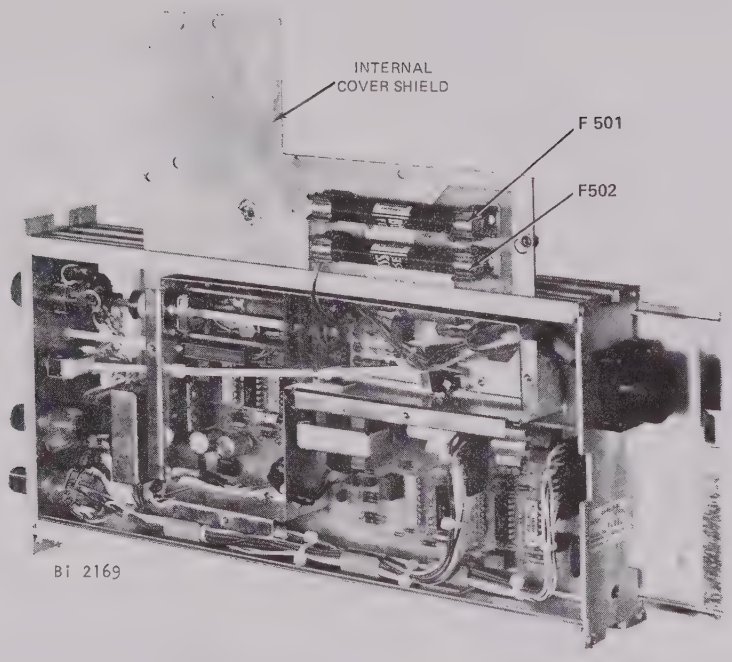


FIGURE 5-1 INPUT FUSE LOCATIONS

1. The Humiseal must be cut away from the bad component before unsoldering the component.

2. Avoid contact with Humiseal when unsoldering the component. Irritating fumes are produced when heated and should be vented away from the technician.

CAUTION: HUMISEAL LIQUID IS FLAMMABLE. DO NOT USE IN PRESENCE OF OPEN FLAME OR SPARKS. AVOID INHALATION OF VAPORS OR SPRAY, & CONTACT WITH SKIN OR EYES. IF CONTACT OCCURS, WASH WITH SOAP & WATER. IF SWALLOWED, CONTACT A PHYSICIAN IMMEDIATELY.

3. Cut any damaged or burnt humiseal away from the area, clean the flux off of the soldered terminals and remove any dirt, wax, grease or moisture from the surface.

4. Heat the surfaces with a heat gun to approximately 40-50° C to drive moisture out.

5. Apply an even coat of humiseal to the area to provide proper insulation for operation.

5.5 CALIBRATION

a. General

The Gould High Voltage Amplifier Model 13-4615-90, has been accurately calibrated before shipment from the factory and should give long trouble free service. Should recalibration be required, it should be performed by qualified technical personnel only.

NOTE: Calibration should not be attempted unless suitable specified test equipment is used. Since special, high precision equipment is required, it is recommended that this model be returned to the factory for recalibration.

b. Test Equipment Required

The following is a list of test equipment necessary for calibration.

1. Extender card and cable assembly, Gould P/N 887291.

2. Digital Voltmeter, 4½ digit.

3. 2000 Series Recorder.

4. Function Generator: Wavetek Model 110 or equal.

5. D.C. Source: 0.5% accuracy; Electronic Development Corp. Model – VS330H or equal.

c. Preliminary Procedure

1. Remove right side cover and inside shield cover from preamp (Figure 5-2).

2. Set Front Panel controls as follows:

   Volts Full Scale switch – 1V position
   Zero Suppression switch – OFF
   Zero Suppression control – Fully CCW
   X1 – X100 switch – X1
   Range switch – X1
   Filter switch – 5Hz
   Sensitivity control – Fully C.W.

3. Connect preamplifier to power source: +15 Vdc and 13Vrms or power from Gould 2000 Series Recorder.

4. Allow unit to warm up for 30 minutes.

d. Phase Control (R203)

1. Turn phase pot (R203) maximum C.W. (See Figure 5-2).

2. Connect DVM to TP1 (+) and TP2 (Common).

3. Connect D.C. power source to input connector J101 pin 1 (high) and pin 2 (low).

4. Apply +.8 volts and adjust phase control (R203) for maximum POSITIVE reading.

e. Output Zero Control (R207)

1. Set Volts Full Scale to OFF position and range switch to X.1.

2. Using the DVM, adjust the Output Zero control (R207) for a reading of 0 ±.001 volts D.C.

f. Balance Control (R408)

1. Short input connector J101; High (Pin 1), Low (Pin 2) and guard of amplifier.

2. Set Volts Full Scale switch to the .025 position.

   Adjust front panel Balance control (R408) to obtain a 0 ±.020 volt reading on the DVM.

g. Offset Control (R406)

1. Set Volts Full Scale switch to the 1 position.

2. Rotate Sensitivity control (front panel) from fully C.W. position to full C.C.W. position. Adjust Offset control (R406) for minimum voltage change as observed on the DVM. Change should be ±.010 volts or less.

3. Return Sensitivity control to maximum C.W. position.

4. Repeat steps f. and g. of this procedure due to interaction betwen calibration controls.

h. Zero Suppression Adjust (R-211 & R-212)

1. Set Range switch to X1 and Volts Full Scale switch to OFF position.

2. Turn the zero suppression vernier to maximum C.C.W. position. The index should indicate 0.0 Rotate vernier C.W. to the 10.0 position and engage the lock.

3. With zero suppression switch (S104) in the OFF position, DVM should indicate reading of 0 ±.005 Vdc.

4. Set Zero suppression switch (S104) to the positive (+) position and Volts Full Scale switch to the 1 position.

5. Adjust the (+) zero suppression control (R211) to obtain a reading of -5V ±.005 Vdc on the DVM.

6. Set Zero suppression switch (S104) to the negative (–) position and adjust the (–) zero suppression control (R212) to obtain +5V ±.005Vdc on the DVM.

7. Set the Zero suppression switch (S104 to OFF.

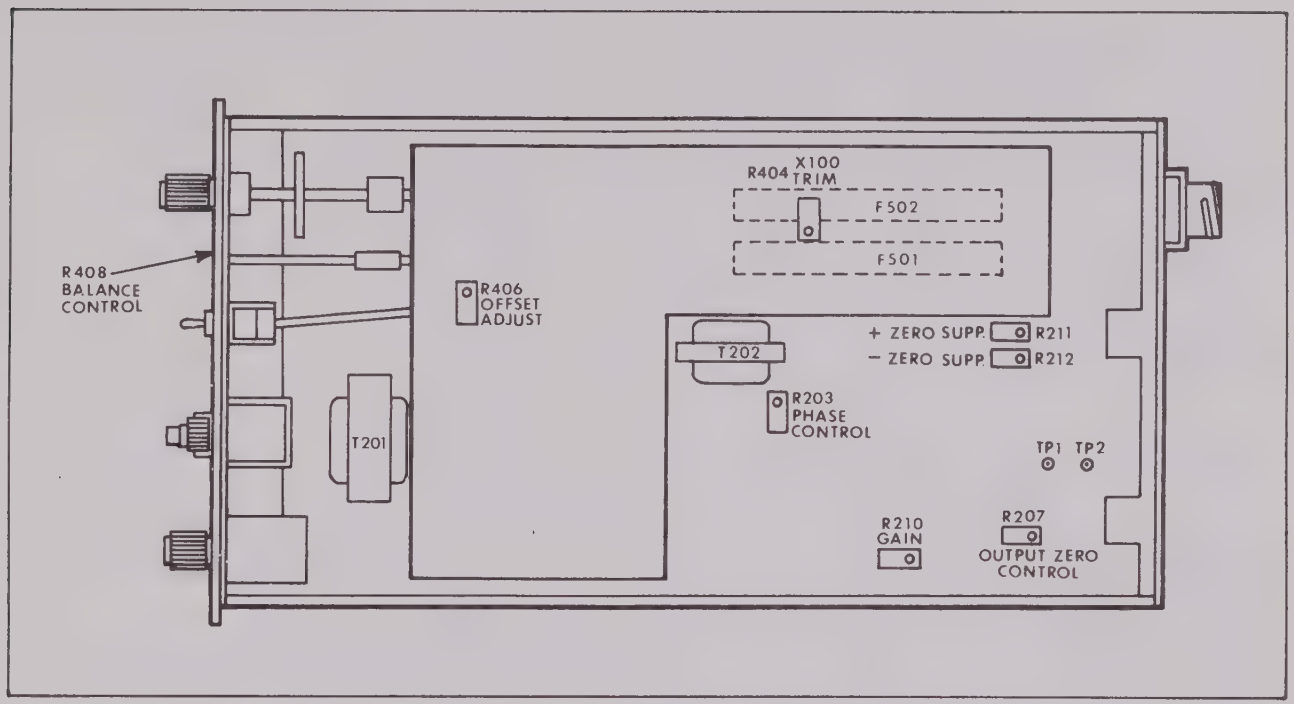


FIGURE 5-2 CALIBRATION CONTROLS

i. Gain Control (R210)

1. Alternately switch the input signal from 0 to +1V ±.0001 Vdc.

2. Adjust Gain control (R210) to obtain a difference reading on the DVM of +5V ±.002 Vdc.

j. X100 Trim Adjust (R404)

1. Set X1-100 switch to X100 position.

2. Alternately switch the input signal from 0 to 100V ±.001 Vdc. and adjust the X100 trim control (R-404) to obtain a difference reading on the DVM of +5V ±.005 Vdc.

5.6 VOLTS FULL SCALE ATTENUATOR CHECK

With the Volts Full Scale switch in the proper posiition, apply a voltage as indicated in Table 5-1 and check for outputs within tolerances stated.

TABLE 5-1

Switch Position Volts Full Scale	Input Change Volts + .01%	Output Change 5.000 VDC
.025	.025	± .035
.050	.050	± .035
.10	.100	± .035
.25	.250	± .035
.5	.500	± .035
1	1.000	± .020
2.5	2.500	± .035
5	5.000	± .035
10	10.000	± .035
25	25.000	± .035

5.7 Amplifier Linearity Check

Set Volts Full Scale switch to 1. Apply a Voltage as indicated in Table 5-2 and check for outputs within tolerances stated.

TABLE 5-2

INPUT	OUTPUT
+1.0 V. ± 001 MV	5.0 V ± 20 MV
+ -.7 V. ± 001 MV	3.5 V ± 27 MV
+ .5 V. ± 001 MV	2.5 V ± 27 MV
+ .2 V. ± 001 MV	1.0 V ± 27 MV
+ .1 V. ± 001 MV	.5 V ± 27 MV
+ .0 V.	0 V ± 5 MV
- .1 V ± 001 MV	- .5 V ± 37 MV
- .2 V ± 001 MV	-1.0 V ± 37 MV
- .5 V ± 001 MV	-2.5 V ± 37 MV
- .7 V ± 001 MV	-3.5 V ± 37 MV
- 1.0 V ± 001 MV	-5.0 V ± 30 MV

5.8 ZERO SUPPRESSION CHECK

Short the input connector pins 1 and 2. Set the X1-X100 switch to X1 and the Volts Full Scale switch to OFF. The Dvm should read 0 ± .005 Vdc.

Turn the Zero Suppression Control fully C.C.W. It should read 0 on the dial. Turn it clockwise to 10.0 and engage the lock. Turn the Zero Suppression switch to the + and – positions and back to OFF. The Dvm should read 0 ± .005 Vdc for all three positions.

Turn the Volts Full Scale switch to the 1 volt position and the Zero Suppression switch to – and then to + suppression. The Dvm should read +5.0V ±.02 Vdc with the switch at – and -5.0V ±.02 Vdc with the switch at +. Leave switch in negative position.

Perform a linearity test using the Zero Suppression pot to set the Dvm voltage and reading the duo-dial as follows:

DVM READING	DUO-DIAL READING
4.0 ± .005	80 ± .5 Div.
3.0 ± .005	60 ± .5 Div.
2.0 ± .005	40 ± .5 Div.
1.0 ± .005	20 ± .5 Div.

Set the Zero Suppression switch to OFF.

5.9 STAR DIAGRAM

In order to facilitate troubleshooting of the Gould High Voltage Amplifier, the following Signal Tracing and Replacement (STAR) Diagram is included. A STAR diagram is a block diagram, expanded to include certain wiring diagram information, schematic diagram information and engineering maintenance information (signal levels, waveforms, test points, etc.). Initially, this diagram can be used in conjunction with the Theory of Operation in Section IV of this manual. As service personnel gain familiarity and experience with the equipment, the need to refer to the supporting descriptive text will gradually be eliminated.

The STAR diagram provides the essential information required to isolate a fault to a functional block. To use the STAR diagram, perform the preliminary setup procedure below. Then by applying the scope probe to each test point, proceed through the unit until the signal you obtain is different from the information on the diagram for that test point. Having done this, the block immediately prior to the "bad" test point indicates in which area the trouble lies. Going to that area on the board (and the schematic), components may be checked to find the failure. Be sure to verify that all power supply voltages are present and correct (Figure 5-3).

1. Set Front Panel Controls as follows:

   (S101) Volts Full Scale – 1V
   (S103) Range – X1
   (R101) Sensitivity – Detent X1
   (S402) Multiplier – X1
   (R102) Zero Supp – 100% For Star 15
   (S105) Filter – 1K
   (S104) Zero Supp. Plus +

2. Remove unit right side cover.

3. Remove internal shield cover.

4. Connect input to power source: +15Vdc and 13 Vrms or power from a Gould 2000 Series Recorder and extender cable.

5. Allow unit to warm up for 15 minutes.

6. Apply 1 Volt DC to input connector J101.

7. Take STARS at the test points called out.

8. Proceed to troubleshoot unit.

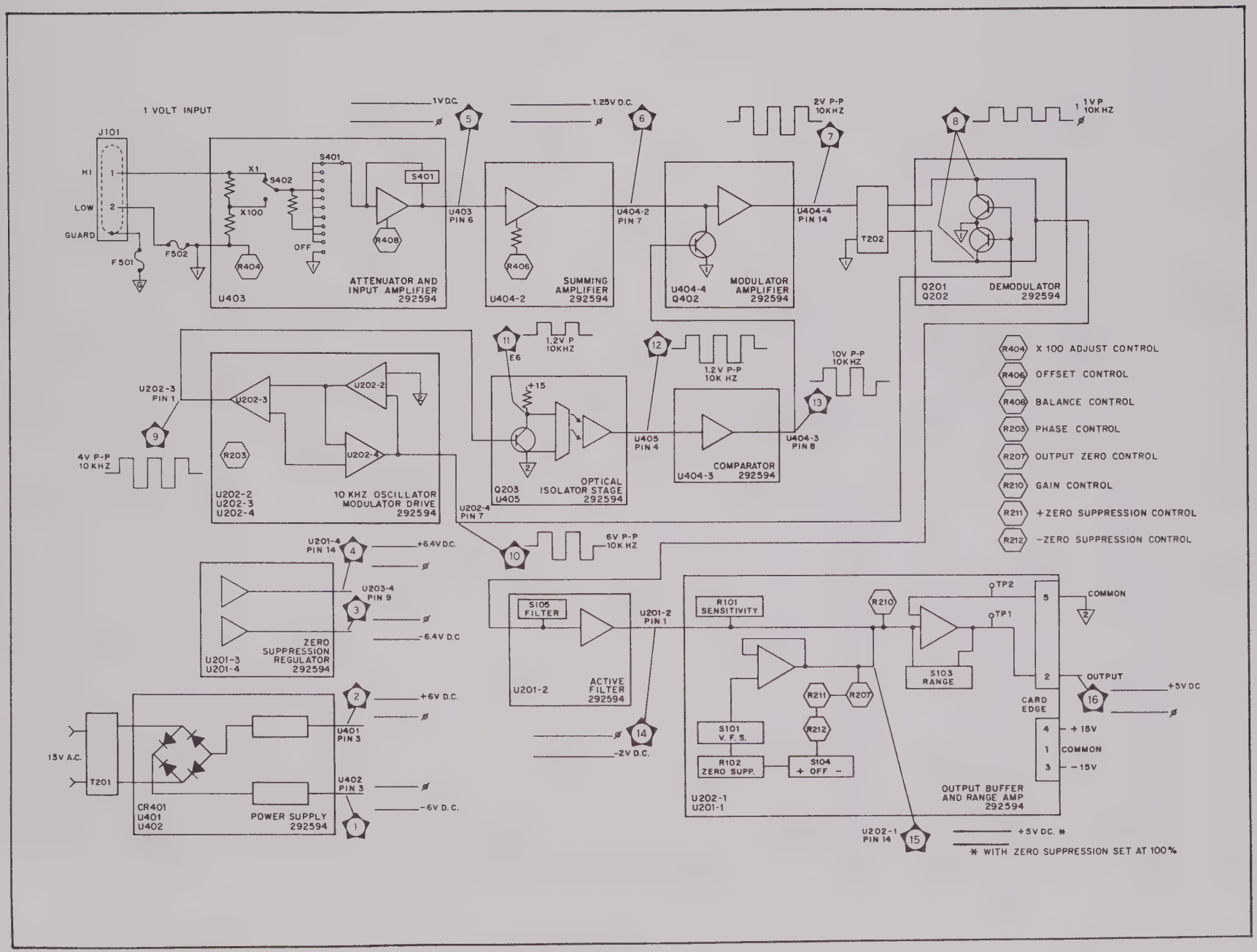


FIGURE 5-3 HIGH VOLTAGE STAR DIAGRAM

SECTION VI

PARTS IDENTIFICATION

6.1 GENERAL

This instrument has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the instrument.

The following parts lists and schematic diagrams are designed to assist in servicing and repairing the instrument.

NOTE: Check to be sure the schematic number and revision letter stamped on the rear of the instrument agree with the number and revision letter on the schematic contained in this section.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name, model number, and serial number of the instrument.

   For Example: High Voltage Amplifier, Model 13-4615-90, Serial Number _____

2. Description of the part as listed in the manual.
3. Gould part number.

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

†Denotes item is not procurable.

EXPLODED VIEW PARTS LIST
HIGH VOLTAGE AMPLIFIER MODEL 13-4615-90
FIGURE 6-1

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
	13-4615-90	Amplifier Assy, High Voltage	
†1	692352	Cover Assy	
	285943	Cover	
	382359-4	Insulator	
2	685944-1	Frame	
3	891208	Board Assy, Output (See Figure 6-2)	
4	891206	Board Assy, Isolation (See Figure 6-3)	
		(A-P)	
	31-119918-4004	Screw, Pan Head	
		----- * -----	
5	127711-3	Bearing, Sleeve Nylon	
6	292578	Shaft, Actuator	
7	790697	Guard	
		(A-P)	
	31-262716-4006	Screw, Self Tapping	
		----- * -----	
8	123108-42	Grommet, Rubber	
	691202	Cable Assy	
9	265760-1	Receptacle, Pin	
10	790696	Guard	
		(A-P)	
	31-262716-4006	Screw, Self-Tapping	
		----- * -----	
11	248490-1	Fuse, HVA 1/8	F501;F502
12	791210	Cover, Shield Assy (Includes item 11)	
	292543	Copper Shield (Part of Item 12)	
		(A-P)	
	31-119918-4004	Screw, Pan Head	
	31-119918-4006	Screw, Pan Head	
		----- * -----	
	691205	Cable Assy (Includes Item 15)	
		(A-P)	
	13-262716-4004	Screw, Self-Tapping	
		----- * -----	
13	0-108400-11	Sleeving, Insulation	
14	265760-2	Receptacle, Pin	
15	785546	Connector, Female	J101
16	285303-1	Contact, Male	
17	785946	Panel, Rear	
		(A-P)	
	13-262716-4004	Screw, Self-Tapping	
		----- * -----	

EXPLODED VIEW PARTS LIST
HIGH VOLTAGE AMPLIFIER MODEL 13-4615-90
FIGURE 6-1 (Continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION	SYMBOL NUMBER
18	245912-6	Coupling, Flex	
19	292253	Shaft, Flex	
		(A-P)	
	31-121166-4002	Screw, Set	
		------ * ------	
20	691204	Switch Assy	
	790688	Switch Assy, Sensitivity	
21	246391-103	Resistor, Variable	R-101
22	230050-103	Resistor, Variable	R-102
23	289890-1	Switch, Toggle	S-104
24	291234	Switch, Rotary	S-101
25	286151-6	Switch, Rotary	S-103
26	287491-12	Connector	A-1 thru A-12
27	1-287490	Contact, Elec	
	790699	Switch Assy, Filter	
28	287491-12	Connector	B-1 thru B-12
29	1-287490	Contact, Elec	
30	232997-23	Strap, Retaining	
31	286151-9	Switch, Rotary	S-105
32	270903-11	Clamp, Cable	
33	392296	Panel, Sub	
		(A-P)	
	13-262715-4004	Screw, Self-Tapping	
		------ * ------	
34	790695	Panel Asys, Silkscreen	
35	285652-1	Knob	
36	285651-12	Knob	
37	285650	Knob	
38	284990	Knob, Turns- Counting	
39	285652-2	Knob	
40	663800-1	Nut, Knurled	
41	292970	Label	

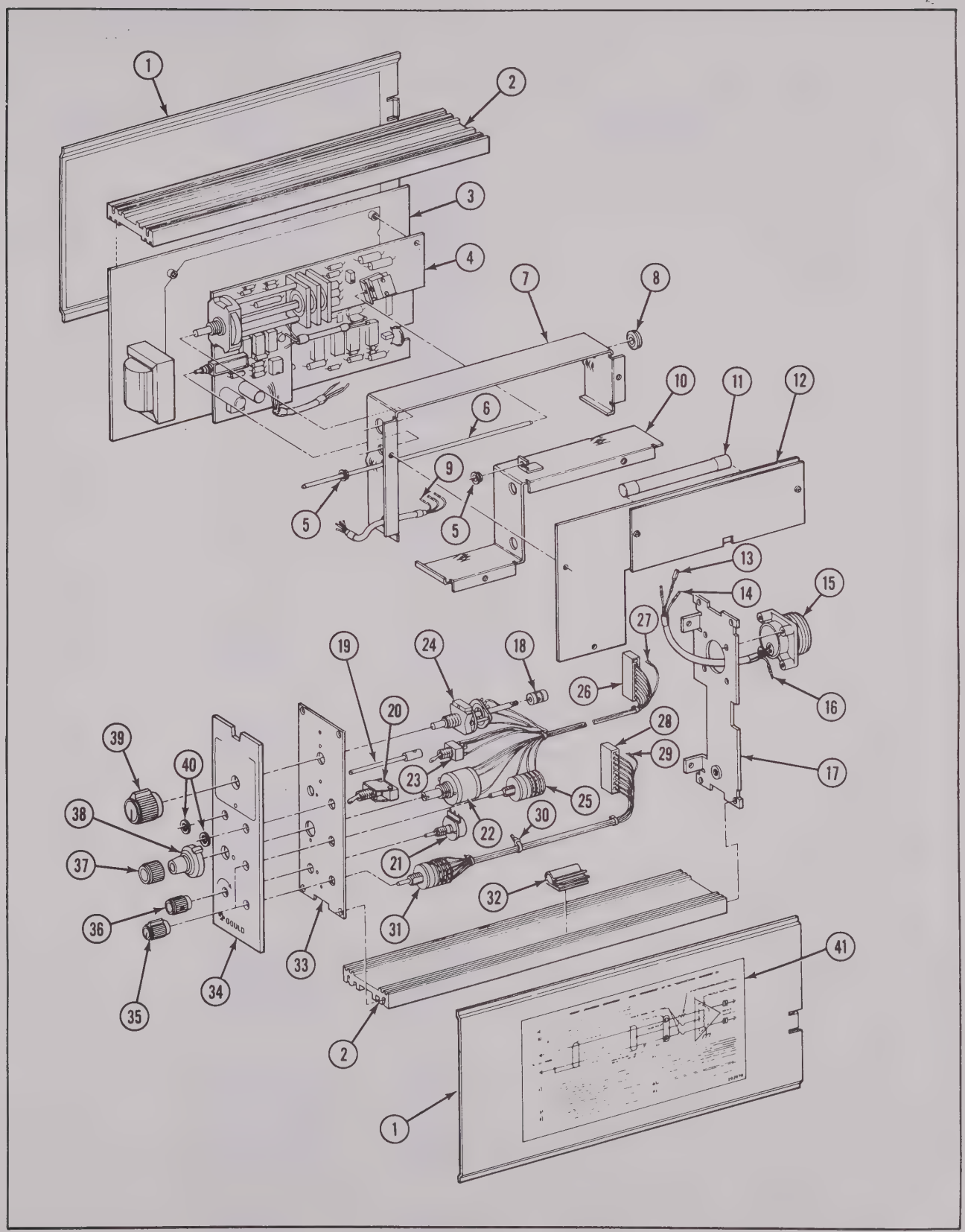


FIGURE 6-1 HIGH VOLTAGE AMPLIFIER

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 891208
FIGURE 6-2

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C201	10-125904-472	Capacitor
C202	288755-102	Capacitor
C203	5-241145-683	Capacitor
C204	5-241145-684	Capacitor
C205	5-241145-204	Capacitor
C206	5-241145-684	Capacitor
C207	5-245923-561	Capacitor
C208	5-241145-682	Capacitor
C209	5-241145-683	Capacitor
C210	5-241145-203	Capacitor
C211	5-241145-683	Capacitor
C212 thru C215	288755-104	Capacitor
C216	240352-103	Capacitor
CR201 thru CR204	280440	Diode, 1N4148
CR205	283166-1	Diode, 1N4576
CR206	280440	Diode, 1N4148
Q201	281702-2	Transistor, 2N4401
Q202	281703-2	Transistor, 2N4403
Q203	281702-2	Transistor, 2N4401
R201	1-288308-700R0	Resistor
R202	5-241111-202	Resistor
R203	269085-202	Resistor
R204	5-241111-103	Resistor
R205	5-241111-472	Resistor
R206	5-241111-472	Resistor
R207	269085-103	Resistor
R208	1-281851-52000	Resistor
R209	R1-284694-10000	Resistor
R210	269085-103	Resistor
R211 & R212	269085-502	Resistor
R213	R1-284694-613R7	Resistor
R214	R1-284694-203R9	Resistor
R215	R1-284694-202R8	Resistor
R216	25-288308-10002	Resistor
R218	25-288308-15001	Resistor
T201	290334	Transformer
T202	293842	Transformer

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 891208
FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
U201	291062-4	Integrated Circuit
U202	291062-3	Integrated Circuit TL084CN
U203	289199	Resistor, Network
U204	291070	Resistor, Network
U205	291071	Resistor, Network
U206	294306	Voltage Regulator
	392254	Insulator
A & B	287495-12	Connector

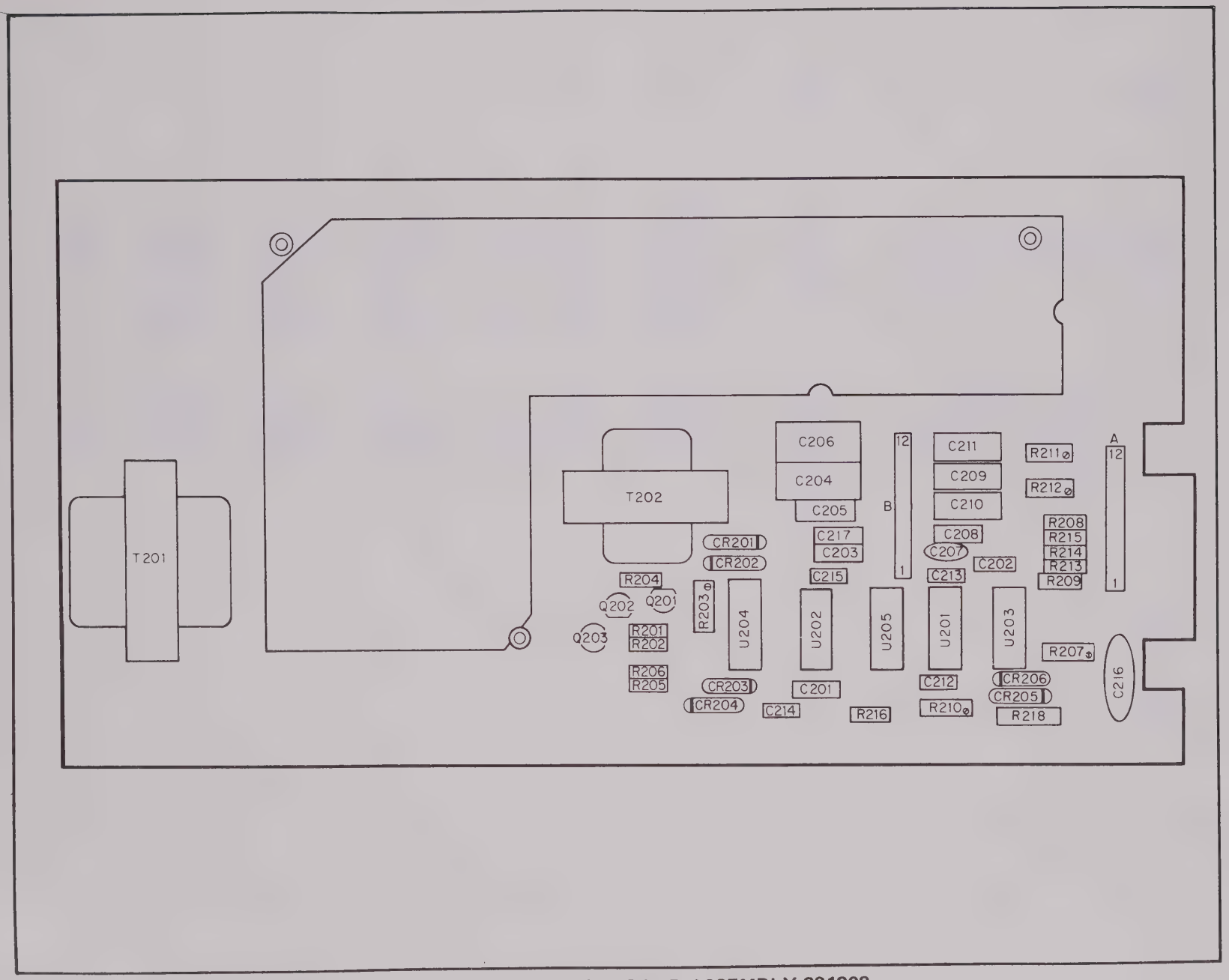


FIGURE 6-2 BOARD ASSEMBLY 891208

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 891206
FIGURE 6-3

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
1	691965	Cable, Assy
2	691203	Cable, Assy
3	292374	Bracket, Actuator
4	282961	Insulator
C401 & C402	269255-107	Capacitor
C405	287614-101	Capacitor
C407	5-241145-163	Capacitor
C408 & C409	288755-104	Capacitor
C410 & C411	262585-475	Capacitor
CR401	291758-1	Bridge, Rectifier VM25
CR403	269256-7	Diode, 1N4007
CR406 & CR407	280440	Diode, 1N4148
Q402	281702-2	Transistor, 2N4401
R401 & R402	R1-281349-49503	Resistor
R403	1-291222-14002	Resistor
R404	269085-103	Resistor
R405	2-290003-12343	Resistor
R406	269085-103	Resistor
R407	R1-288308-12461	Resistor
R408	292127	Resistor
R409	1-292410-50002	Resistor
R412	R1-288308-10001	Resistor
R414	R1-288308-40001	Resistor
R415	R1-288308-53330	Resistor
R416	R1-288308-17780	Resistor
R417	R1-288308-467R8	Resistor
R418	R1-288308-215R9	Resistor
R419	R1-288308-205R9	Resistor
R422 & R423	5-241111-100	Resistor
R424	1-290003-4002	Resistor
R425	5-241111-512	Resistor
R427	1-281851-15001	Resistor
R428 & R249	R1-288308-40001	Resistor
R430	1-292410-50002	Resistor
R431	25-284694-15001	Resistor
S401	291233	Switch, Rotary
S402	2-282296	Switch

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 891206
FIGURE 6-3 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
U401	291999	Voltage Regulator, MC7806C
U402	292000	Voltage Regulator, MC7906C
U403	292409	Integrated Circuit, 3527BM
U404	291062-3	Integrated Circuit, TL084CN
U405	691476	Integrated Circuit, Hi-Pot
U406	291068	Resistor, Network
U407	291069	Resistor, Network

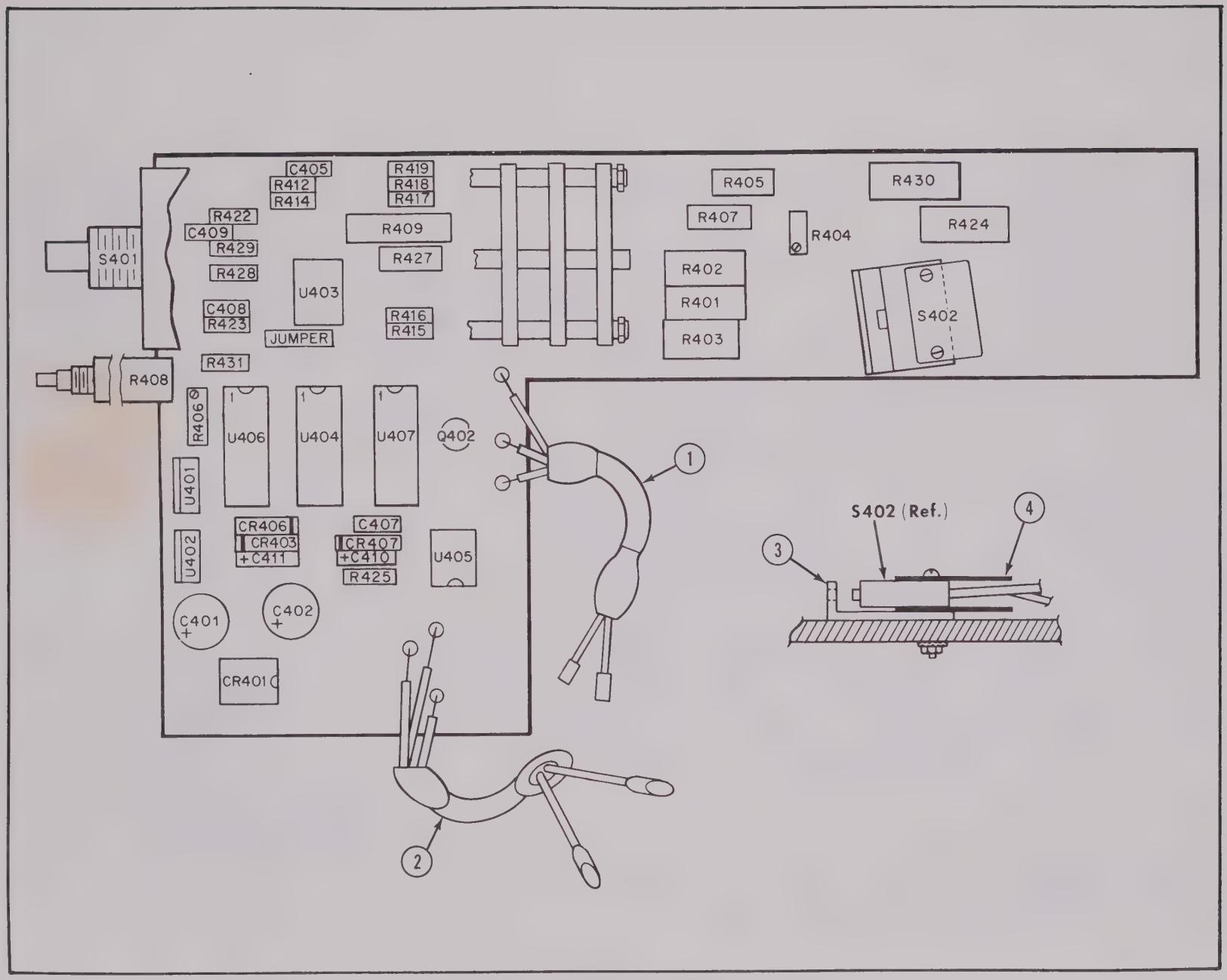
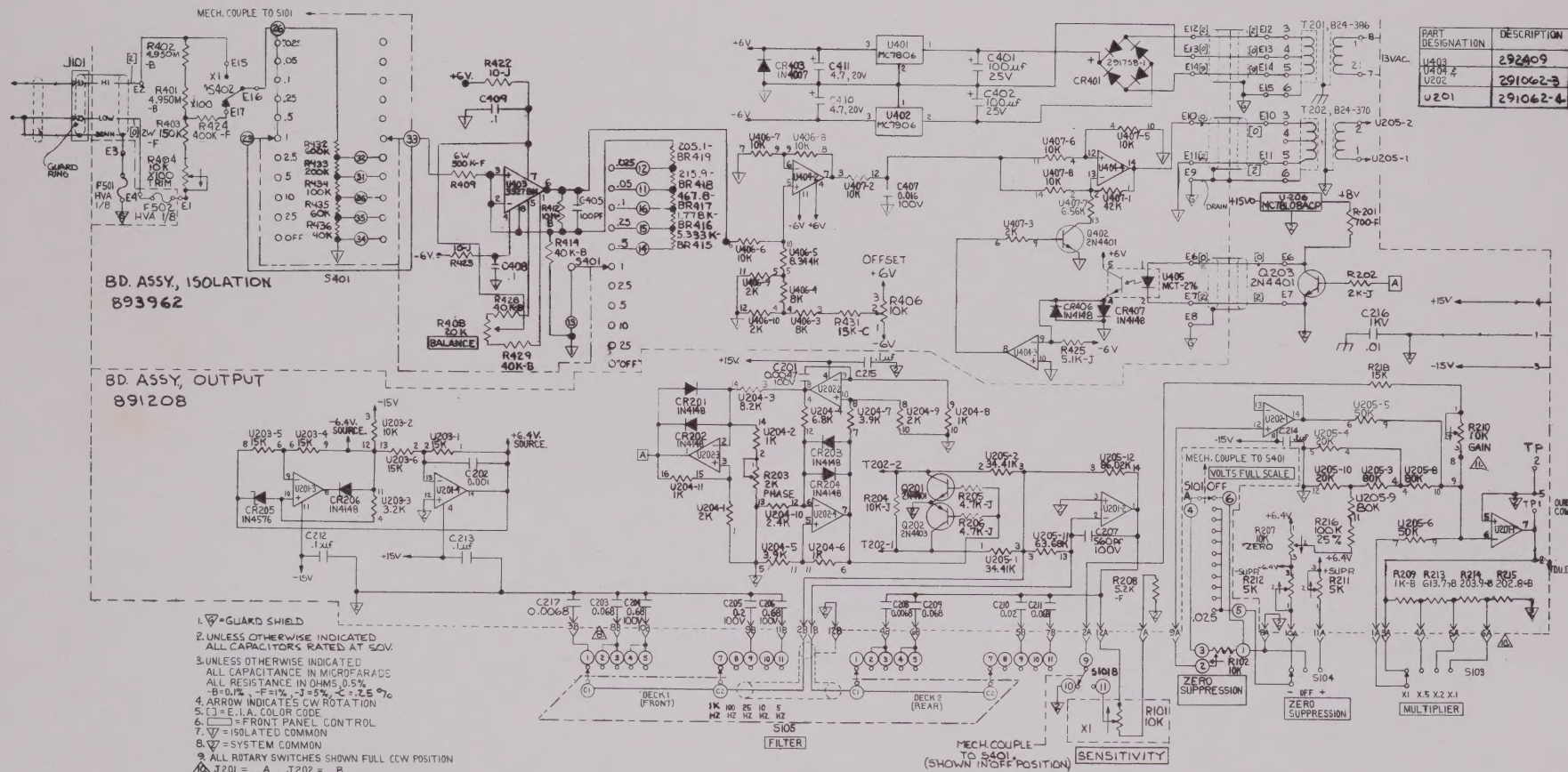


FIGURE 6-3 BOARD ASSEMBLY 891206

REVISION A-1



PART DESIGNATION	DESCRIPTION
U403	292409
U404	
U202	291062-3
U201	291062-4

1. ▽ = GUARD SHIELD
2. UNLESS OTHERWISE INDICATED ALL CAPACITORS RATED AT 50V.
3. UNLESS OTHERWISE INDICATED ALL CAPACITANCE IN MICROFARADS ALL RESISTANCE IN OHMS, 0.5% -B=0.1%, -F=1%, -J=5%, -C=.25%
4. ARROW INDICATES CW ROTATION
5. [ ] = E.I.A. COLOR CODE
6. ▭ = FRONT PANEL CONTROL
7. ▽ = ISOLATED COMMON
8. ▽ = SYSTEM COMMON
9. ALL ROTARY SWITCHES SHOWN FULL CCW POSITION
10. J201 = _A , J202 = _B
11. U205-7: WHEN PRESENT STOCK IS USED UP THE SHORT ACROSS U205-7 PINS 8 & 9 WILL BE ELIMINATED, AND R218 WILL GO FROM 15K±1% T-9 TO O.A. JUMPER.
12. WHEN S101 IS IN OFF, SWITCH CONTACT ⑨ IS CONNECTED TO CONTACT ⑩, IN ALL OTHER POSITIONS OF S-101 ⑨ IS CONNECTED TO ⑪.

NOTES:

BY	DATE	NAME	SCHEMATIC	Gould Inc. Instruments Division Cleveland, Ohio 44114 U.S.A.
DR A. SOTEROS	12-4-79	MODEL NO.: 13-4615-90		DWG NO. 293190
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